Roll No. .....

Total No. of Questions : **9**] [Total No. of Printed Pages : **4**

**(2032)**

## UG (CBCS) IIIrd Year (Annual) Examination

# 3226

2022

## B.Sc. PHYSICS

### (Elements of Modern Physics)

(DSE-1A)

**Paper : PHYS 301 TH**

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**Time : 3 Hours]** **[Maximum Marks : 50**

***Note*** :– Attempt *five* questions in all, selecting *one* question from each Section–B, C, D and E. Question No. **1** (Section–A) is compulsory.

### Section–A

### (Compulsory Question)

2 each

1. (a) Why Compton Shift is not observed with visible light ?

(b) Why retarding potential applied to plate in Franck-Hertz Experiment ?

(c) What is an Operator ?

(d) Give *two* reasons that electron cannot exist inside the Nucleous.

(e) What is Internal Conversion ?

(f) What is relation between activity and half life of radioactive substance ?

(g) What are properties of a good moderator ?

## Section–B

2. (a) Deduce relation between angle of scattering of a photon and direction of recoil electron in Compton scattering.

(b) A photon of wavelength 1.02 Å is scattered through 90° by free electron. Calculate change in wavelength of photon. 6.3

3. (a) Describe Franck-Hertz Experiment. How does this experiment shows discrete energy levels in an atom ?

(b) State and prove Bohr's correspondence principle. 6.3

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## Section–C

4. (a) What is Heisenberg's uncertainty principle ? Apply this principle to calculate minimum energy of harmonic oscillator.

   (b) Using uncertainty principle calculate energy of particle confined to region of space. 5,4

5. (a) Derive time independent Schrödinger equation.

   (b) Normalize the wave function given by :

$$\psi(x) = \begin{cases} A \sin \dfrac{\pi x}{a}, & \text{for } 0 < x < a \\ 0, & \text{outside} \end{cases}$$ 5,4

## Section–D

6. What do you mean by particle in a box ? Determine energy levels and normalized wave functions for particle in a box. 9

7. (a) What is binding energy ? Explain variation of binding energy per nucleon with mass number (A).

   (b) What are magic numbers ? Give experimental evidence for their existance. 5,4

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## Section–E

8. (a) What are different modes of β-decay ? Under what conditions do they occur ?

   (b) Explain Geiger-Nuttal Law. Discuss its importance. 5,4

9. (a) What is a chain reaction ? What are factors on which escape of neutrons depends ?

   (b) Discuss construction and working of a nuclear reactor. 5,4

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Roll No. .....

Total No. of Questions : 9] [Total No. of Printed Pages : 4

(1109)

# UGC (CBCS) Vth Semester (New) Examination

# 1204

## PHYSICS

(Elements of Modern Physics)

(DSE)

PHYS 501

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**Time : 3 Hours]** **[Maximum Marks : 50**

*Note* :– Attempt *five* questions in all, selecting *one* question from each Section B, C, D and E and *seven* sub-questions from Section A. Question No. 1 is compulsory.

### Section–A

1. Attempt any *seven* sub-questions :

   (i) Why wave nature of matter is not apparent in daily observation ?

   (ii) State *two* drawbacks of Rutherford's atomic model.

(iii) Which of the following is not a form of uncertainty principle ?

(a) $\Delta x \ \Delta p \geq h/2\pi$

(b) $\Delta E \ \Delta t \geq h/2\pi$

(c) $\Delta E/\Delta f \geq h/2\pi$, $f$ means frequency

(d) $\Delta f/\Delta E \geq h/2\pi$

(iv) What do you mean by normalisation of a wave function ?

(v) For a particle of energy E less than step potential $V_0$, the Reflection coefficient is :

(a) 1

(b) 0

(c) Greater than 1

(d) Less than 1

(vi) Compute that 1 amu = 931 MeV.

(vii) State limitations of liquid drop model.

(viii) What is a moderator ? Give *two* examples.

(ix) What do you mean by nuclear holocaust ? 2×7=14

## Section–B

2. Describe in detail the Davisson and Germer Experiment. State its importance. 9

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3. State postulates of Bohr's theory and deduce an expression for the energy of $n$th orbit of H-atom. Obtain an expression for wave number and explain spectra of H-atom as Lyman, Balmer, Paschen, Brackett and Pfund series. 9

## Section–C

4. (a) State and explain Uncertainty Principle for position and momentum. Using it calculate binding energy of electron in H-atom.

   (b) How gamma ray microscope illustrates uncertainty principle ? 5,4

5. (a) Derive an expression for expectation value of position, momentum and energy operators.

   (b) What is physical meaning of probability current ? 6,3

## Section–D

6. Obtain an expression for energy eigen values and normalised eigen wave functions for a particle in an infinitely rigid one dimensional box. 9

7. (a) Discuss semi-empirical mass formula of a liquid drop model. Explain significance of various terms involved in it.

   (b) What are magic numbers ? Why number of neutrons tends to exceed number of protons in stable nuclei ? 6,3

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## Section–E

8. (a) What are β-rays ? Discuss its spectra. What led Pauli to postulate the existence of neutrino ? Mention the properties of neutrino too.

   (b) 20 mg of a radioactive substance of half life 1 year is kept in a box for 4 years. How much of it will disintegrate in 4 years ? 6,3

9. (a) Define Q-value of a nuclear reaction. Obtain an expression for it and hence derive the condition for exoergic and endoergic nuclear reactions.

   (b) Compare energy released in nuclear fission of 1 kg of $_{92}U^{235}$ with fusion of 1 kg of $_{1}H^{1}$. 7,2

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Total No. of Questions : 9] [Total No. of Printed Pages : 4

(2041)

# UG (CBCS) IIIrd Year (Annual) Examination

2021 Question Paper

# 2526

## B.Sc. PHYSICS

## (Elements of Modern Physics)

(DSE-1A)

**Paper : PHYS 301 TH**

downloaded from hpexamhub.in

**Time : 3 Hours]** **[Maximum Marks : 50**

*Note* :– Attempt *five* questions in all, selecting *one* question from each Sections–B, C, D and E. Question No. **1** (Section–A) is compulsory.

## Section–A

## (Compulsory Question)

1. (a) Explain dual nature of material particles.

(b) Write drawbacks of Rutherford's model of atom.

(c) What are Eigenvalues and Eigenfunctions ?

(d) For $n = 1$, find the energy of an electron in a box of length 1 Å.

(e) Find the relation between Electron-volt and Atomic Mass Unit.

(f) Define the main two units to measure the intensity of radioactivity.

(g) What is γ-rays Emission ? 2 each

## Section–B

2. (a) What is Compton Effect ? Derive an expressi for the wavelength of scattered photon in Compton effect. 4

(b) Also calculate the expression for the kinetic energy of the recoil electron. 3

(c) Why is observation of the Compton shift difficult with visible light ? 2

3. (a) Describe Davisson and Germer experiment for the diffraction of electrons. What role did it play in the varification of de-Broglie hypothesis ? 6

(b) What is de-Broglie wavelength of an electron which has been accelerated from rest through a potential difference of 100V. 3

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## Section–C

4. (a) Explain Uncertainty Principle. How did Heisenberg show $\Delta x.\Delta p \geq \hbar/2$ ? Using this principle calculate the binding energy of an electron in hydrogen atom. 6

   (b) An electron has a speed of 500 $ms^{-1}$ correct up to 0.01% with what mininum accuracy can you locate the position of this electron. 3

5. (a) Derive the Schrödinger equation for a free particle in one dimension. 5

   (b) Derive an expression for the expectation value of momentum and energy operators. 4

## Section–D

6. A particle of mass $m$ and total energy E moves from the region of zero potential to the region of constant potential $V_0$. Given that $E > V_0$, derive expressions for reflection coefficient R and transmission coefficient T. Prove that $R + T = 1$. 9

7. Discuss the semi-empirical mass formula of liquid drop model. 9

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## Section–E

8. (a) What do you understand by Half-Life and Mean Life of a radioactive substance ? 6

   (b) The half-life of radon is 3.8 days. After how many days, one per cent of radon will be left behind ? 3

9. Discuss the following terms :

   (a) Nuclear Fuel

   (b) Moderators

   (c) Control Rods

   (d) Coolant 2,3,2,2

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Roll No. .....

Total No. of Questions : 9] [Total No. of Printed Pages : 4

(2102)

# UG (CBCS) IIIrd Year Supplementary Examination

# 2789

## B.Sc. PHYSICS

### (Elements of Modern Physics)

(DSE-1A)

Paper : PHYS 301 TH

**Time : 3 Hours]** **[Maximum Marks : 50**

*Note* :– Attempt *five* questions in all, selecting *one* question from each Sections–B, C, D and E. Question No. 1 (Section–A) is compulsory.

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## Section–A

### (Compulsory Question)

1. (a) Explain the broadness of the modified Compton peak.

   (b) What is fine structure of an atom ?

   (c) Write condition of orthogonality of two wave functions.

(d) A particle in a box cannot have zero energy quantum mechanically. Explain.

(e) Compute energy equivalence of 1g in kWh.

(f) Positron emission and electron capture process complete with each other. Explain.

(g) Differentiate between X-ray and $\gamma$-rays. $2\times7=14$

## Section–B

2. (a) What is Photoelectric Effect ? Give an experimental study of this effect. What were the conclusions drawn from this experiment ?

(b) Derive expression for De-Broglie wavelength associated with an electron. 6,3

3. (a) State the Bohr's postulates and deduce the expression for energy of electron in $n$th orbit of H-atom.

(b) What are the limitations of Bohr's theory ? 6,3

## Section–C

4. Explain the validity of uncertainty principle using :

(a) Gamma ray microscope

(b) Diffraction of electron beam at slit . 5,4

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5. (a) What are Operators ? Explain energy operator, momentum operator and Hamiltonian Operator.

(b) A particle is described by wavefunction :

$$\psi(x, t) = \frac{1}{\sqrt{2a}} e^{i(kx-\omega t)} \text{ in } (-a < x < a)$$

Find average momentum of particle. 6,3

## Section–D

6. (a) A particle of mass $m$ and energy ($E < v_0$) moving in $x$-direction incident on potential barrier :

$$V(x) = \begin{cases} 0 & , x < 0 \\ v_0 & , x \geq 0 \end{cases}$$

Show that reflection coefficient $R = 1$.

(b) Discuss possibility of finding particle in region ($x \geq 0$), where $V(x) = v_0$. 6,3

7. Write short notes on the following :

(a) Nuclear density

(b) Mass defect

(c) Magnetic moment of the nucleous 3,3,3

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## Section–E

8. (a) Discuss the theory of successive decay and obtain conditions for transient and secular equilibrium.

   (b) The Half life of Radon is 3.8 days. After how many days, one percent of Radon will be left behind. 6,3

9. Write short notes on the following :

   (a) Nuclear Fission

   (b) Nuclear Fusion

   (c) Slow and Fast Neutrons

   (d) Nuclear Reaction 2,2,3,2

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2023

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Total No. of Questions : **9]** [Total No. of Printed Pages : **4**

**(2033)**

## UG (CBCS) IIIrd Year Annual Examination

# 3295

## B.Sc. PHYSICS

**(Elements of Modern Physics)**

(DSE-1A)

**Paper : PHYS 301 TH**

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**Time : 3 Hours]** **[Maximum Marks : 50**

***Note*** :– Attempt *five* questions in all, selecting *one* question each from Sections–B, C, D and E. Question No. **1** (Section–A) is compulsory.

### Section–A

### (Compulsory Question)

1. (i) Why is observation of Compton Effect difficult with visible light ?

   (ii) Why is the wave nature of matter not apparent in our daily observation ?

(iii) What is the importance of normalising a wave function ?

(iv) What are Eigen values and Eigen function ?

(v) Why is that electrons cannot be inside the nucleus ?

(vi) Differentiate between artificial and natural radioactivity.

(vii) Write a short note on 'Thermal Neutrons'. 2×7=14

## Section–B

2. (i) Describe the Einstein's theory of photo-electric effect. How does it explain the laws of photoelectric emission ?

(ii) Describe Davisson-Germer experiment for the diffraction of electrons. What role did it play in the verification of de-Broglie hypothesis ? 5,4

3. (i) Explain the various reasons for the acceptance of the Rutherford nuclear atom model.

(ii) Describe Bohr's postulates and derive the formula for Balmer series of hydrogen lines. Calculate the radius of first Bohr orbit. 5,4

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## Section–C

4. (i) Explain uncertainty principle in Quantum mechanics and by using it calculate binding energy of electron in hydrogen atom.

   (ii) A proton and deuteron have the same kinetic energy. Which one of them will have longer wavelength ? 5,4

5. (i) Derive time dependent Schrödinger equation and from it obtain the time independent Schrödinger equation.

   (ii) Explain expectation value of an operator and the need to define it. 5,4

## Section–D

6. (i) What do you mean by a particle in a box ? Obtain expression for energy levels and normalised wave functions for a particle in a box.

   (ii) Calculate the zero point energy of a simple harmonic oscillator. 5,4

7. (i) Derive the semi-empirical mass formula of liquid drop model.

   (ii) What are nuclear forces ? In what respects do they differ from electrostatic and gravitational forces ? 5,4

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## Section–E

8. (i) What is natural radio-activity ? Explain the terms Half-life and Mean-life and derive a relation for them.

   (ii) Give the origin of neutrino and antineutrino. 5,4

9. (i) What are the different types of nuclear reactions ? Discuss with examples and derive an expression for the Q-value of the reaction.

   (ii) Discuss the role of cadmium control rods in a nuclear reactor. 6,3

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Mid Term Test

Time: 1h

Subject: Elements of Modern Physics (PHYS301TH)

MM: 15

B.Sc 3rd Year

**Note:** All questions are compulsory.

Section: A

Q.1 (a) State laws of Photoelectric emissions.

(b) What is De-Broglie hypothesis?

(c) What are the problems with Rutherford model?

2X3=6

Section B

Q.2 (a) State the postulates of Bohr's Theory of hydrogen atom. Derive the expression for the energy of electron in nth orbit of hydrogen atom.

6

Or

Derive expression for linear and angular momentum operators. Prove that px and py operators commute with each other.

(b) If the De-Broglie wavelength of an electron is $9X10^{-10}$ m. Calculate its kinetic energy. 3

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